



White Paper

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Installation of an Upgraded, Energy Efficient HVAC System for Dumbarton House

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The National Society of The Colonial Dames of America

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Project Activities

Major activities of the project followed the outline presented in the grant application, with a modified schedule. Accomplishments and changes are included below.

FALL 2015 (Oct-Nov 2015)

- Thermal Conductivity Test
 - As part of another grant project, a thermal conductivity test was conducted to determine whether the ground surrounding Dumbarton House would conduct heat appropriately to be effective for a geothermal system. Funded in part by the National Endowment for the Humanities Dorothea de Schweinitz Fund for DC, the study found the ground did effectively conducted heat.
- Internal Project Meeting
 - DH staff met to review the project work plan, assign tasks, and determine next steps. Revisions to the work plan were suggested and made, as reflected below.
 - The grant award was announced to our Board and publically via social media.
 - Plans were adjusted to account for two additional significant, grant-funded projects also awarded:
 - IMLS Interpretive Planning grant
 - IMLS Collections Storage grant
- Collections Assistant Hired
 - Rather than recruit, train, and hire multiple collections interns to support the collections packing and cataloguing required at the front end of this project, the team decided to recruit a part-time Collections Assistant to work hourly from Fall, 2015 – Fall, 2016.
- Met Michael Henry
 - The project team reached out to noted preservation architect & engineer Michael Henry to review the project work plan, goals, and timeline.
 - Watson & Henry Associates was contracted to serve as owner's advocate/advisor throughout the project design. Henry's first recommendation, embraced by the team, was to schedule a full team planning workshop in the winter to refine project goals and define project scope and requirements (budget, timeline, etc.)

WINTER 2015-2016 (Dec 2015-Feb 2016)

- RFPs out for Architect & Engineer
 - Based on advisor recommendations, project work plan refined to reflect architect as lead, coordinating contracting of engineer, project manager, etc.
- Architect Hired

SPRING 2016 (Mar-May 2016)

- Full Day HVAC Planning Workshop
 - Michael Henry facilitated a full day workshop with our comprehensive project team and advisors, including: Quinn Evans architects, DH staff on project team (director, curator,



collections & facilities manager), collections assistant, consulting conservator, Engineers, and Board members.

- Major accomplishments/decisions of the workshop included: focusing our temperature and humidity ranges for zones throughout the site; prioritizing restoration of window and installation of storm windows in the historic core as part of this project; recommendation/requirement to move all collections and all staff/office operations off-site throughout the 6 month project period; decision to contract a construction/project manager to serve as general contractor and assist with planning and coordination leading up to project start.
- Budget revised post-workshop to include changes.
- Engineers & Civil Engineers Contracted
- Solicited Proposals for Window Restoration
 - Proposals sought for restoration of all windows on the historic core and installation of storm windows, to assist with ability to maintain humidity control in the museum exhibition spaces after new HVAC installation.
- Construction Manager Contracted
- Began Seeking Temporary Office Space for HVAC work
 - Temporary Office space sought for DH staff being displaced by work for approx. 6 months.

SUMMER 2016 (Jun-Aug)

- Received HVAC system designs & began permit review process
 - Designs for geothermal heating/cooling system received; permit process begun; and Section 106 review process begun.
- Weekly HVAC Project Calls Begun
 - Weekly project calls (rather than monthly or quarterly as originally expected) initiated to enable all key team members to keep track of permit status, section 106, budget, design questions, etc.
- Received preliminary cost proposal from subcontractors
 - Project manager sought preliminary budget estimate using draft designs; confirmed revised budget estimate of about \$1million for construction costs.

FALL 2016 (Sep-Nov)

- Received notice of DCCAH Grant
 - DC Commission on the Arts and Humanities awards Dumbarton House a \$55,000 grant to support the HVAC replacement project as part of their Facilities & Buildings grant program.
- Temporary Office Space Leased
- Museum Closes to the Public; Collections Packed; Movers Scheduled
- Offices Packed and Readied; Movers Scheduled
- Received notice of price escalation as subcontractor bids received; project design reevaluated
 - Despite summer preliminary estimates, project bids from multiple subcontractors come in at a total of \$1.8-1.9million for geothermal HVAC system as designed.



- Emergency team meetings called to evaluate reasons for cost escalation and determine best path forward.
- Engineers worked with HVAC contractor to provide alternate designs to bring construction costs back down toward the \$1million level. The selected alternative meant changing course from geothermal and considering a VRF (variable refrigerant flow) system. The VRF system priced at about \$1.2million and would still provide significantly more efficiency than a chiller/boiler system.

WINTER 2016-2017 (Dec - Feb)

- Spent the 11 days working nonstop with the project team to figure out how to keep the project on track with our timeline and get the costs back in line with our budget. (Note: we had a \$1.3m board-approved budget for full project costs—including construction costs + architectural, engineering, office move, permits, etc.)
- Identified a path forward and work began on a revised design.
 - Instead of geothermal, a VRF (variable refrigerant flow) system was decided upon as the most cost effective and efficient. It is much more efficient than a chiller-boiler system, but not quite as efficient as a geothermal system.
 - In terms of up-front costs based on current, actual bids from HVAC contractors, the VRF project comes in at about \$1.2m construction costs versus \$1.5m construction costs for chiller/boiler versus \$1.8m construction costs for geothermal. The greater efficiency of the geo system can NOT make up for the \$600k up-front cost differential.
- Through the winter the bulk of the actual construction work commenced. Following is a chronology of the major events of the HVAC project:

Date	Activity
2016-NOV-17	Keys to Dumbarton House handed over to Corbett Construction
2016-NOV-28	Demolition phase of the project began: <ul style="list-style-type: none"> - Work began in the Belle Vue Room (BVR) removing the ductwork from the ceiling. - Removed chandelier from BVR and stored in collection storage room
2016-DEC-08	Old chiller dismantled and removed
2016-DEC-12	Window removal from Historic Block of house
2016-DEC-12	Old boiler dismantled and removed
2017-JAN-04	All wall sconces in BVR removed and boxed for rewiring
2017-JAN-12	Revised mechanical drawings submitted for permitting
2017-FEB-07	Window reinstall begins
2017-FEB-22	Window reinstall complete
2017-MAR	Installation of ductwork begins
2017-MAR-03	Last of outdoor VRF units delivered and placed on utility pad
2017-MAR-07	Air handlers and humidifiers installed



Date	Activity
2017-MAR-08	Inspections begin on ductwork
2017-MAR-10	Drywall and patching begins
2017-MAR-22	Painting begins

- Hard hat “Preservation in Action” tours conducted for neighbors, the public, and colleagues. The Virginia Association of Museums and Historic House Museum Consortium of DC co-sponsor a member “meet up” at one, drawing about two dozen DC area museum professionals to tour the construction and hear about our lessons learned on the project.

SPRING 2017 (Mar-May 2017)

- Return to the historic site
 - Beginning in March, plans are made for our return to Dumbarton House for office operations beginning in April, with a public reopening scheduled for June 1.
- In early April the contractors turn the keys back over to the staff and a special dinner is held for our Board to celebrate the end of the project and successful fundraising to match our NEH award. Board member themselves donated a significant portion of the match funds, with additional contributions coming from NSCDA members nationally, some local neighbors, and earned revenue primarily through historic site rentals for private events.
- Annandale Balancing Company conducts third-part testing and balancing of the HVAC system, submits report on May 3, 2017 (full report included in appendices).
- As we return to the site, we experience a few issues with the HVAC system that we work with contractors to iron out.
 - There was a leak (twice) in the West Wing unit that damaged the ceiling in the development office necessitating the replace of a broken piece on the HVAC unit and replacement of the ceiling in the office.
 - There continue to be intermittent problems with even cooling throughout the rooms in office spaces.
 - Problems with the software controls and the hardware controls continued to have issues with the set points for temperature and humidity through June.

SUMMER 2017 (Jun-Aug 2017)

- The museum officially reopens to the public with a ribbon cutting the first weekend of June. Attended by our DC Council Member Jack Evans and scheduled to coincide with Dupont Kalorama Museum Walk Weekend, over 1,000 visitors from the region (many first time visitors) attend the free reopening weekend tours.
- Third part Commissioning of the System is conducted.
- Return air grills for both the West Wing and the Second Floor Museum have been exhibiting a humming noise since installation.
 - West Wing grill was removed as the noise was too loud for people to concentrate on their work. It was determined that the grills were too flimsy for the system. The air intake was so strong that it caused the grills to vibrate.



- July 28, 2017 the grill in the Second Floor Museum replaced with a sturdier grill. A new grill for the West Wing installed on August 6, 2017.
- As part of the HVAC project storm windows with UV filter film were installed in June throughout the historic block of the house.
 - As a result of the addition of the storm windows we have seen a far tighter control of the temperature and humidity levels in the period rooms and galleries.

FALL 2017 (Sep)

- Final meetings are held and payments issued
- Staff begin work on final reports and proposals for upcoming professional conferences.

Changes to the Project Team

Though we had not originally budgeted to include Michael Henry on our project team, his involvement has proven invaluable throughout the process—both as we refined our project goals and timeline/work plan, and most recently as we’ve dealt with the crisis of having to consider major changes to our system design within a very tight timeframe. Having an advocate on our team with architectural, engineering, and preservation expertise has helped us ask better questions and demand better answers/solutions from our other contractors, and will enable us to achieve the best possible system for our historic site and collections in the end (even if it isn’t the exact system we imagined when we started this process).

In our original application we identified architect Outerbridge Horsey to consult on the project. However after our review of the project scope and initial planning workshop, Quinn Evans (architects Tom Jester & John Whitaker) proved to be the best fit for this preservation project.

We worked with Wendy Jessup as consulting conservator (instead of Brian Ramer, who retired after application submitted, before award received). Wendy Jessup (resume included in appendices) was subcontracted through Michael Henry and participated in the invaluable full day HVAC Planning Workshop in March, 2016.

Funding/Fundraising

Our NEH grant awarded \$250,000 outright and \$50,000 as a match to help fund this HVAC replacement project. We received a \$55,000 grant award from the DC Commission of the Arts and Humanities, and over \$20,000 specifically restricted from individuals to support this project. In addition, we received a generous unrestricted \$1million pledge (over \$250,000 paid on the pledge to date) from an individual to support this effort and other strategic plan priorities at Dumbarton House. To assist with any cash flow needs as additional gifts were solicited and pledges realized, a line of credit was opened with Bank of America-US Trust. In the end, the accumulated contributions, grant funds, and earned revenue fully funded the project and the line of credit has not been utilized.

Accomplishments

In a nutshell, the accomplishments of this grant project included the total replacement of our HVAC system for the historic Dumbarton House. Additionally, historic windows were fully restored, interior



storm windows installed, and insulation added to the attic—all dramatically improving the building envelope, evidenced by the now narrow range of temperature and humidity control maintained in the historic period rooms (attached in the appendices). Finally, this project raised Dumbarton House's visibility in the professional community and allowed us to serve as a resource for peers working on HVAC replacement and upgrade projects in historic buildings regionally, and even nationally.

Audiences

The replacement of the HVAC system has impacted all 20,000+ annual visitors to the historic site, as well as volunteers (approximately 40) and staff (11 full-time, 6 regular part-time, and 12 seasonal). Specifically, the new system has significantly improved the comfort of our visitors, staff, and volunteers—improving staff and volunteer morale, without sacrificing appropriate temperature ranges for collection preservation.

Additionally, the project allowed us to host preservation-focused hard-hat tours for neighbors, colleagues, and preservation-enthusiasts; and reach a national audience through blog and social media posts. The Executive Director and Collections & Facilities Manager have already begun presenting on the project at professional conferences (AAM 2016, AASLH & VAM 2017), and will continue to do so moving forward—expanding the reach of the project further within the field. Just last week, our Collections & Facilities Manager hosted a pair of National Park Service Rangers from the Belmont-Paul Women's Equality National Monument to assist with their research on HVAC systems for historic structures.

Evaluation

Professional evaluation was not a component of this project, but internal evaluation, undertaken during the grant period, included testing and balancing the new HVAC system and then commissioning it by a 3rd party to ensure all components are functioning as designed and meeting our building needs.

Evaluation will continue after the grant period through quarterly monitoring, to include:

- HOBO monitoring of temperature and humidity levels in collections display and storage areas to determine the effectiveness of the new system at mitigating humidity spikes and maintaining consistent temperature and humidity levels within our target ranges;
- Staff and volunteers will be surveyed to determine building comfort in office and public areas of the site, and to determine staff comfort with system controls and operational responsibilities;
- Energy costs will be tracked and recorded to assess monthly year-to-year comparisons before and after the HVAC system upgrade, and to initiate operational changes as needed; and HVAC system maintenance costs will be tracked and recorded, as well, to conduct a post-project cost-benefit analysis, comparing lifetime costs of the new system to the old.

The system upgrade will have a profound impact on improving the environmental conditions for the museum's humanities collections. The new system has enabled us to segment the museum spaces into refined zones—allowing us the ability to set varying temperature and humidity levels based on the needs of the zone. The dedicated collection storage space, for example, is regulated to a more stringent temperature/humidity range that is entirely uncomfortable for humans, while the offices and program



spaces can be set to human comfort levels. The new system also gives us greater control over seasonal spikes in temperature and humidity, which are dangerous to the collections. Moisture alarms installed in the collections areas inform staff immediately of any liquid threat to the collection, so that such threats can be mitigated before damage is done to the artifacts. Finally, timers and computerized thermostat controls enable staff to more efficiently and effectively manage energy consumption—so that collections areas can be maintained at constant target ranges 24/7, while non-collection spaces can be “turned off” when not in use, and scheduled to “come on” in advance of the building opening.

In terms of implementation, the biggest challenge we faced with this project was the escalation of mechanical costs for the geothermal system when it came time to actually secure proposals and contracts. Our preliminary research, conducted through an NEH Planning Grant, had indicated geothermal to be the best and most cost effective option for our site, and so we had focused much of our research and planning on that type of system—even beginning design of the system and permitting based on geothermal. Thus, when the contractor bids came in almost double what had been estimated just a few months before, we were stunned. After years of research and planning for geothermal we had to immediately change course and redesign our entire system, quickly learning about alternatives and then securing necessary approvals to move forward. Postponing the project was not feasible at this late date—the collections had already been packed and moved off site, the lease for temporary office space signed, public notice of the site closure already posted, and contracts for private event rentals for the following spring/summer were already in hand. This change was costly—both in terms of additional architectural and engineering fees, and in terms of staff time and morale. Already stretched thin with responsibilities of implementing the site closure and move of offices and collections offsite, key project team members now had to exert tremendous time and effort into changing course.

Through this process the advice and counsel of Michael Henry, proved invaluable. He helped us break down the technical language and varying perspectives of the engineers, architects, and mechanical system contractors on the team, and was able to “tutor” us quickly and effectively on the benefits of a VRF system based on his vast experience in this area. In the end, we are all pleased with the resulting system and decision to change course, despite the tremendous initial stress it caused.

Continuation, Long Term Impact, & Products

This HVAC system upgrade will have a long-term impact on our historic site and collections—specifically enhancing the safety of the collection by improving the environmental conditions of the museum and dedicated storage area by bringing them to museum standard. Additionally, our upgraded system is more energy efficient and environmentally sustainable. The new system has enabled us to segment the museum spaces into refined zones—allowing us the ability to set varying temperature and humidity levels based on the needs of the zone. The new system is also giving us greater control over seasonal spikes in temperature and humidity, which are dangerous to the collections. Moisture alarms installed in the collections areas will inform staff immediately of any liquid threat to the collection, so that such threats can be mitigated before damage is done to the artifacts. Timers and computerized thermostat controls



are enabling staff to more efficiently and effectively manage energy consumption—so that collections areas can be maintained at constant target ranges 24/7, while non-collection spaces can be “turned off” when not in use, and scheduled to “come on” in advance of the building opening.

While we are still tracking energy consumption with the new system, we anticipate cutting our usage of gas and electricity significantly because of the upgraded duct work, appropriately insulated pipes, and up-to-date technology consisting of more efficient component parts. System temperature controls are available from one computer workstation both locally and remotely. Finally, our new system is significantly improving the comfort of our visitors, staff, and volunteers—enhancing staff and volunteer morale, without sacrificing appropriate temperature ranges for collection preservation.

This project and NEH support for it has elevated the visibility of Dumbarton House in the professional community, and allowed us to serve as a resource for colleagues nationally who are working on upgrading their climate control systems in historic buildings. Staff will continue to seek out opportunities to share our experience with other historic sites and museums to serve as a model, building on existing relationships strengthened through this grant project. Specific collaborations will continue with NSCDA museum properties nationally (over 90 historic sites and collections are owned, managed, or supported by the NSCDA in 44 states and England); DC Preservation League; Historic House Museum Consortium of DC; Virginia Association of Museums; Small Museum Association; American Association for State and Local History; National Trust for Historic Preservation; the DC Office of Historic Preservation; American Alliance of Museums; local universities (George Washington, Georgetown, Howard, American, Catholic, George Mason, etc.); and the Mayor’s Office.

Products include:

- Presentations:
 - Environmental Sustainability – Power, Influence and Responsibility; panel discussion at American Alliance of Museums Annual Meeting, May 2016, included Executive Director Karen L. Daly speaking on behalf of historic sites and sustainability
 - Preservation and Construction at an Historic House – Sharing the Experience of Dumbarton House, February 16, 2017 @ 6:00 pm-7:30 pm, held at Anderson House, presented by Jerry L. Foust, Ph.D. Collections & Facilities Manager, Dumbarton House Museum.
 - Association of Preservation Technology – Washington, DC Chapter, May 12, 2017 Symposium. Presentation “HVAC and the Historic House, or How I Learned to Stop Worrying and Love the Chaos,” Jerry L. Foust, Ph.D., Collections & Facilities Manager, Dumbarton House Museum.
 - Lessons Learned: Undergoing a Major Project at a Small Historic Site, Webinar for the NSCDA, conducted by Jerry L. Foust, Ph.D., Collections & Facilities Manager, Dumbarton House Museum
 - The Value and Responsibility of Environmental Sustainability at Sites and Museums: What Do You Want to See?; panel discussion at American Association of State and Local History Annual Meeting, included Executive Director Karen L. Daly



- Virginia Association of Museums Annual Conference 2018. Presentation: “HVAC and the Historic House Museum: What the Hell Happened?” Jerry L. Foust, Ph.D., Collections & Facilities Manager, Dumbarton House Museum. Forthcoming.
- Blog Posts
 - “Georgetown’s Dumbarton House Museum Reopens” by John Whitaker, AIA, June 2, 2017 on Quinn Evans Architects Blog
 - “The Collection Move: Plan, Plan, and Plan Some More” by Jerry L. Foust, Ph.D, on Dumbarton House website Blog

Key Lessons Learned:

- Expect the scope of a project of this scale to expand once you start planning; particularly if closing your site is part of the plan
 - Once we sat down to plan the HVAC it became immediately clear that we should coordinate the window restoration, interior storm window installation, attic insulation, and collections storage upgrade with this effort, both because the site would be closing (and collections removed) and because we could work with one project manager to oversee all the related trades for all projects
- Plan to close the site and turn it over to contractors from the beginning, if at all possible
 - We spent a lot of time planning to stage the implementation to avoid having to close, in the end realizing it would cost significantly more money and take significantly longer to stage the project in that way. Unless your budget is endless and your schedule completely flexible, plan to close the site and turn over the keys to the contractors from the beginning.
- Hire an Owner’s Advocate/Advisor
 - This was the single best decision we made during this project, even though it cost us a bit more than we had planned to spend in this area. Particularly in small museums, we all wear multiple hats and no matter how skilled we may be, none of us are going to be perfectly equipped to manage all types of facilities projects (on top of programming and fundraising and exhibitions, etc.). An owner’s advocate can serve as an impartial advisor, translating the trades/contractors and helping to advocate for your site and needs.
- Confirm all budget estimates with multiple reliable contractors
 - Our Life Cycle Cost Benefit Analysis was conducted by a firm located a bit distant from the immediate DC metro region—in the end probably explaining at least part of the faulty budget estimates we were working with—so try to use an estimator in your immediate area. Also, make sure the contractors you’re seeing preliminary estimates for are sincerely interested in your project and have enough information to make a reliable estimate.
- No matter how much time or how many staff hours you add/allocate for the packing and preparation to move out, you will always wish you had more



- Even with a collections assistant brought on for a year to do nothing but pack and update catalogue records, we were still scurrying at the end to finish wrapping and packing all artifacts for transport to the offsite collections storage area.
- Spend at least a little time learning about the options you are not pursuing for your project, just in case you have to change course later
 - We had discounted VRF systems early during our planning grant research because that type of system is typically installed with large units on walls of spaces that couldn't accommodate ductwork (which would be unsightly and inauthentic in our historic house). In actuality, VRF systems can be ducted and are quite efficient in comparison to chiller-boiler systems. Spending a little more time during the planning stage to truly understand the different systems may have helped us feel more comfortable later when we had to quickly change course.
- The move back is even more exhausting than the move out
 - And, related, you can never plan enough “perks” to help staff get through this big a project. While moving back to the site should feel rewarding and come with a big sigh of relief that the project is complete, the reality is that we are still unpacking office files and hanging pictures on our office walls—a full 8 months after moving back to the site. Remaining largely operational even while closed, and not building in down time for staff after the return to the site, significantly impacted morale and energy for at least a few months upon our return. Scheduling in more buffer time and allocating more budget dollars toward extra help (movers, cleaners, even administrative support) would have been immensely beneficial.
- Interior Storm Windows can make a significant positive impact on your ability to control temperature and humidity levels in your historic site
 - Staff were suspicious of the value we would see from this aspect of the project, since earlier energy audits did not identify the windows as an area with significant heat transfer. In the end, though, our data loggers confirm a sizeable improvement in temperature and humidity consistency in the historic museum period rooms immediately after installation of the storm windows.
- Hire really good people
 - In the end, this kept us all sane and focused and able to laugh at ourselves throughout. We knew we had strong colleagues to rely on and skilled/expert advisors and contractors to work through issues with as they arose.

